Answers of sheet (1)

D. C. Generators

(1) SEDCG, $R_f = 100\Omega$, $R_a = 1\Omega$, motor constant $K = 0.5$ V/Wb.rad/sec

$V_f = 200V$, $I_{Load} = 10A$, $N_m = 1500$ rpm

Req:- (1) E_a and V_1

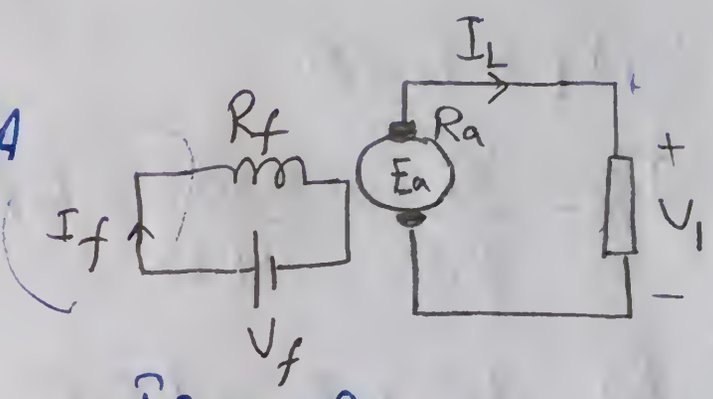
(2) if I_{Load} doubled, V_f = const. → N_m = ? to keep V_1 the same.

Solution

(1)

$\therefore E_a = V_1 + I_a R_a$, $I_a = I_L$

$\because E_a = K_v I_f \omega_m$, $I_f = \frac{200}{100} = 2A$



$I_f \propto \phi \rightarrow wb$

$\omega_m = N_m * \frac{\pi}{30} = 1500 * \frac{\pi}{30} = 157.1 \frac{rad}{sec.}$

$\therefore E_{a_1} = 0.5 * 157.1 * 2 = \boxed{157.1\ V}$

$\therefore V_1 = E_a - I_a R_a = 157.1 - 10*1 = \boxed{147.1V}$

(2)

$I_{L_2} = 2 I_{L_1} = 20A = I_{a2}$, $K = \frac{0.5\ V}{Wb\ \ 1}$

$V_2 = V_1$

$\therefore E_{a2} = V_1 + I_{a2} * R_a$

$\therefore E_{a2} = 147.1 + 20*1 = \boxed{167.1V}$

$\because E \propto I_f \omega_m$, I_f Const.

$\therefore \frac{E_{a1}}{E_{a2}} = \frac{\cancel{I_{f1}}\ \omega_{m1}}{\cancel{I_{f2}}\ \omega_{m2}}$

$\therefore \omega_{m2} = E_{a2} * \frac{\omega_{m1}}{E_{a1}} = 167.1 \frac{rad}{sec}$

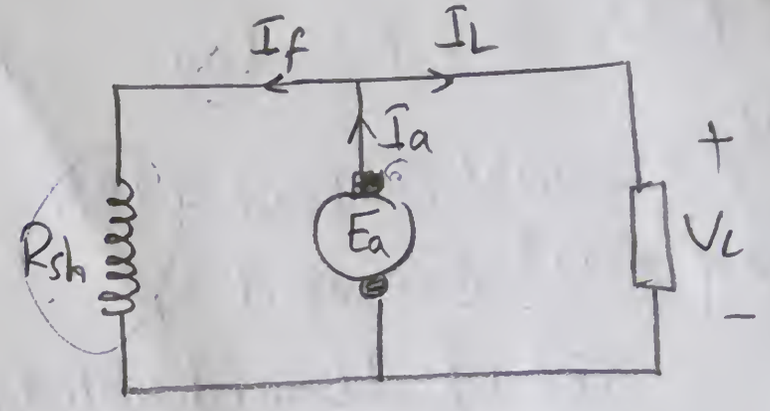
$\therefore N_{m2} = 1595.68$ rpm

② Shunt D.C.G , $P_{out} = 24\,Kw \rightarrow V_L = 200V$

$R_a = 0.05\,\Omega$, $R_{sh} = 40\,\Omega$

Req:- $P_{copper} = P_{friction} + P_{iron}$

① $P_{i/p} = ?$ ② $\eta = ?$



Solution

$P_{out} = I_L . V_L \quad \therefore I_L = \frac{P_{out}}{V_L} = \frac{24*10^3}{200}$

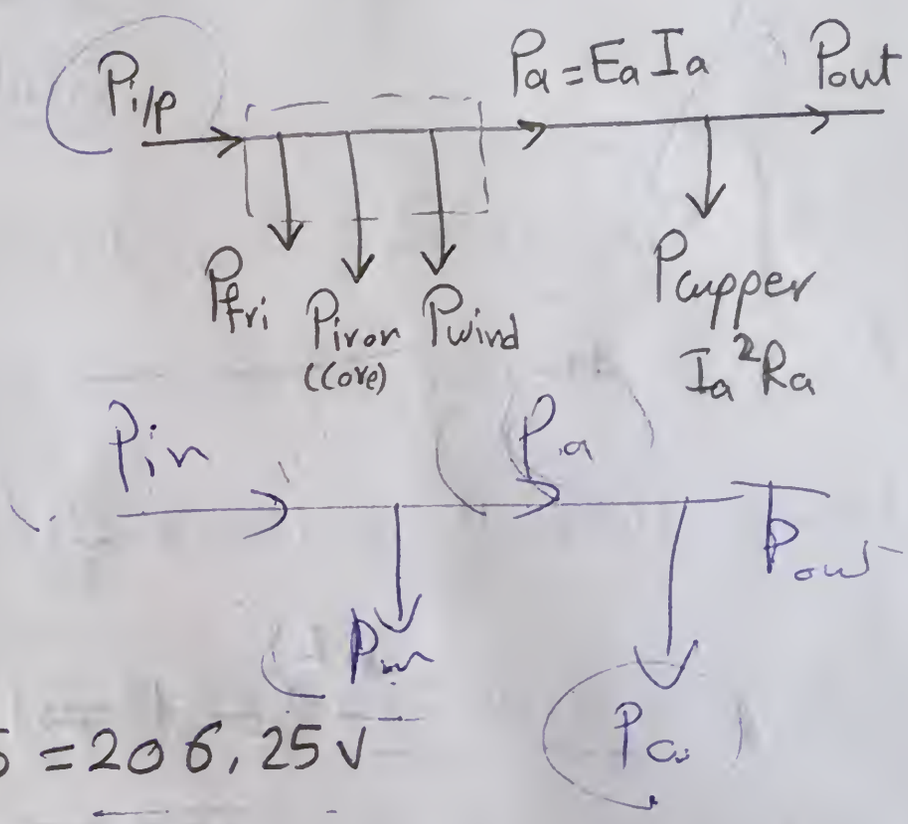
$\therefore I_L = 120\,A$

$I_f = \frac{V_L}{R_{sh}} = \frac{200}{40} = 5\,A$

$\therefore I_a = I_f + I_L = 125\,A$

$\therefore E_a = V_L + I_a R_a = 200 + 125 * 0.05 = 206.25\,V$

$\therefore P_a = E_a . I_a = 25.781\,Kw$



$\therefore P_{copper} = I_a^2 R_a + I_f^2 R_f = 1781.25\,W = P_{fric.} + P_{iron}$

$P_{i/p} = P_a + P_{fri} + P_{iron} \rightarrow = P_{copper}$

$\therefore P_{i/p} = 27.562\,Kw$

$\therefore \eta = \frac{P_{o/p}}{P_{i/p}} * 100 = 87.71\,\%$

nunt D.C.G., $I_L = 100A$, $V_L = 220V$, $\eta = 0.86$

$P_{fri} + P_{wind} + P_{core} = 1.1 Kw$, $R_{sh} = 110\,\Omega$ ... Req: $R_a = ?$

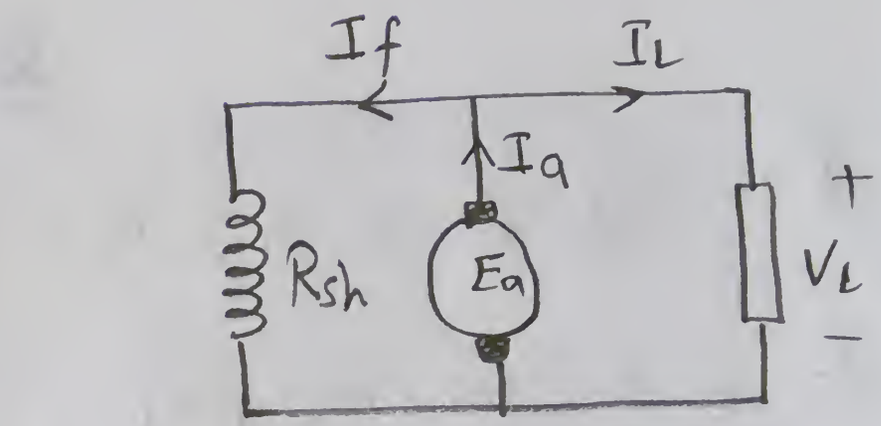
Solution

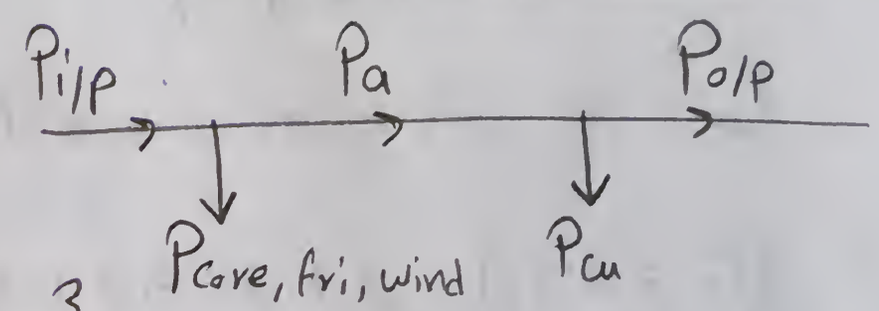
$$I_f = \frac{V_L}{R_{sh}} = \frac{220}{110} = 2A$$

$$\therefore I_a = I_L + I_f = 102A$$

$$\because E_a = I_a R_a + V_L$$

? ? ✓ ✓





$$P_{out} = I_L \cdot V_L = 100 * 220 = 22\ Kw$$

$$\therefore \eta = 0.86 = \frac{P_{out}}{P_{in}} \quad \therefore P_{in} = \frac{P_{out}}{\eta} = \frac{22 * 10^3}{0.86}$$

$$\therefore P_{in} = 25.5814\ Kw$$

$$\because P_{in} = P_a + P_{core,fri,wind}$$

$$\therefore P_a = P_{in} - P_{core,fri,wind} = 24.4814\ Kw$$

$$\because P_a = E_a I_a$$

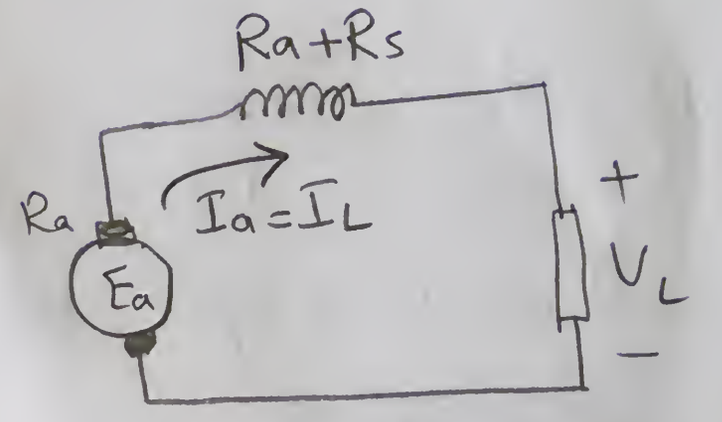
$$\therefore E_a = \frac{P_a}{I_a} = 240V$$

$$\therefore R_a = \frac{E_a - V_L}{I_a} = \boxed{0.196\,\Omega \cong 0.2\,\Omega}$$

④ $P_{out} = 50Kw$, $V_L = 250V$, series G., $Ra = 0.02\Omega$, $Rs = 0.045\Omega$

$P_{stray} = 2.5Kw$ Req; at rated load

① I_a ② Σ_a ③ $P_{copper\ arm.}$ ④ $P_{copper\ field}$ ⑤ η



Solution

$$P_{out} = I_L . V_L \quad \therefore I_L = I_a = \frac{50 * 10^3}{250} = 200A$$

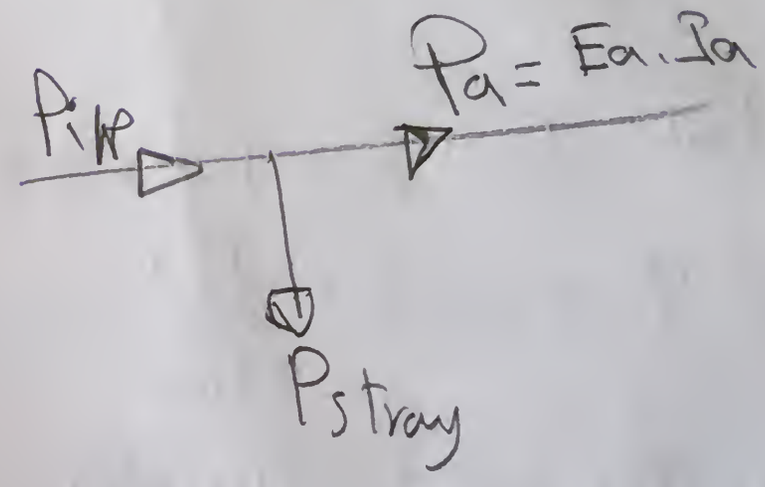
$$\therefore E_a = I_a (R_a + R_s) + V_L$$

$$\therefore E_a = 200 * (0.02 + 0.045) + 250 = 263V$$

$$\therefore P_a = E_a I_a = 52600 \text{ watt} = 52.6 Kw$$

$$P_{cuarm.} = I_a^2 R_a = 800w$$

$$P_{cufield} = I_a^2 R_s = 1800w$$



∴ from the Power flow diagram

$$\therefore P_{in} = P_{stray} + P_a = 52.6 * 10^3 + 2500 = 55.1 \text{ kw}$$

$$\therefore P_{in} = 55.1 \text{ kw}$$

$$\therefore \eta = \frac{50}{55.1} * 100 = 90.7\%$$